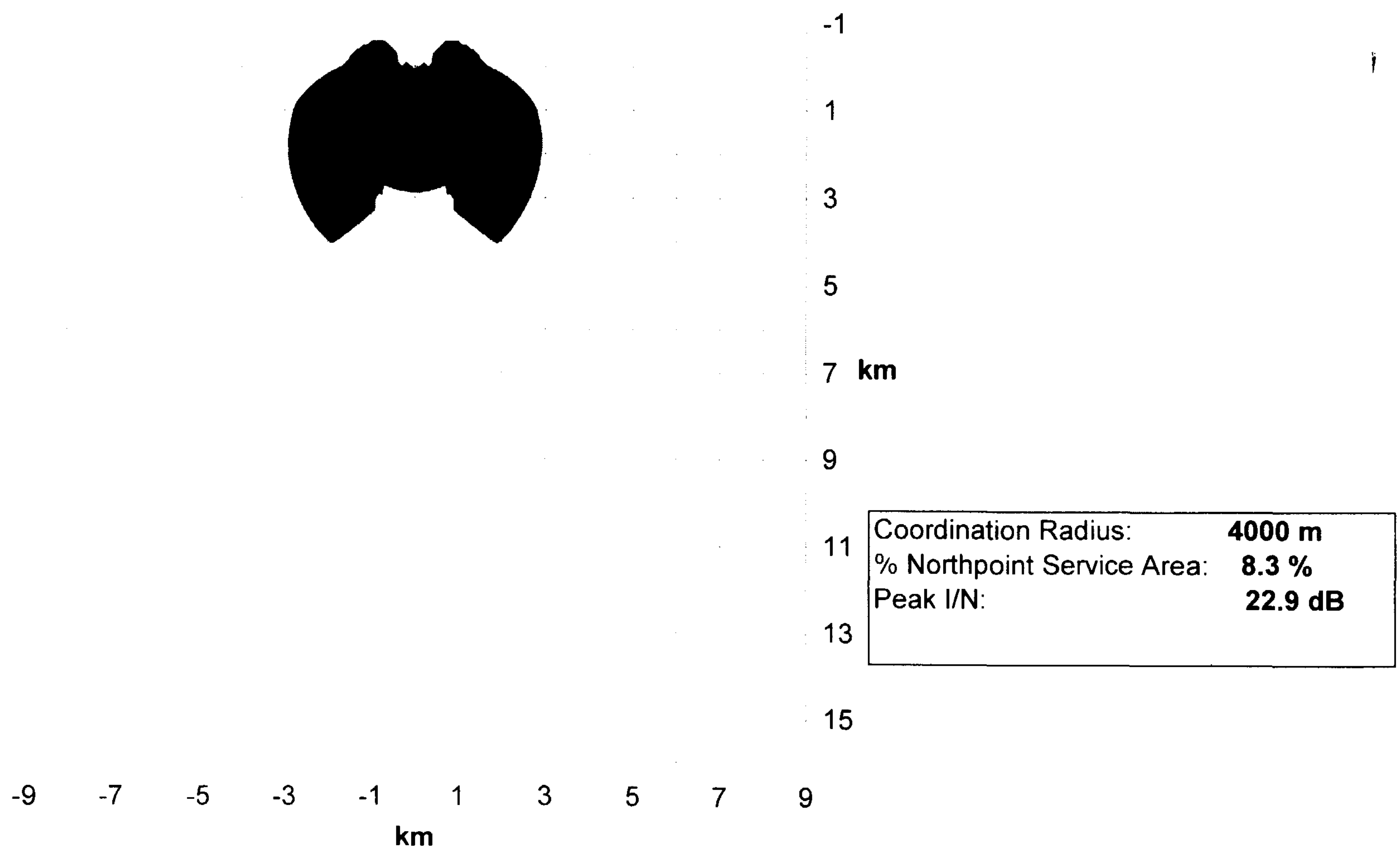
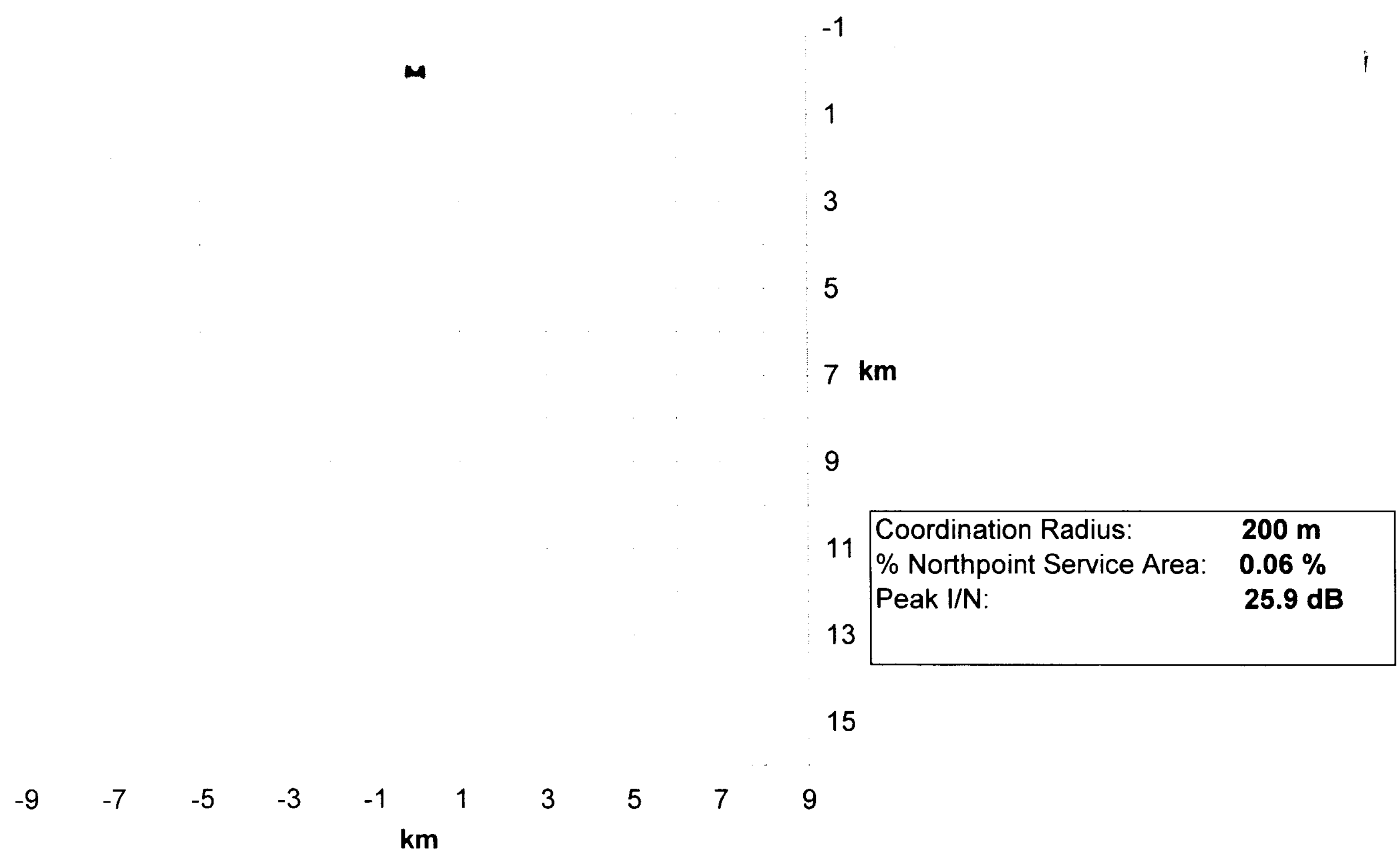
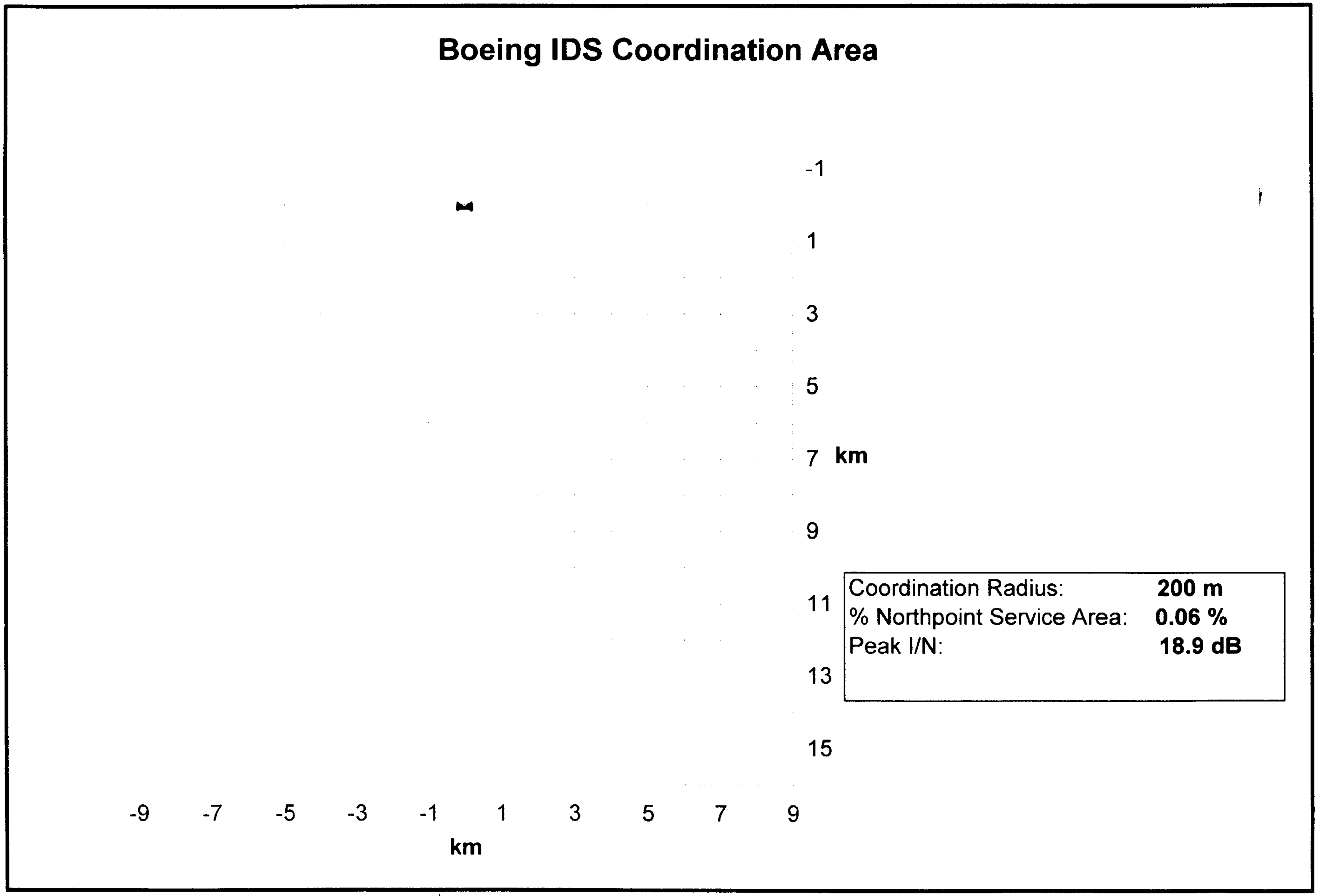
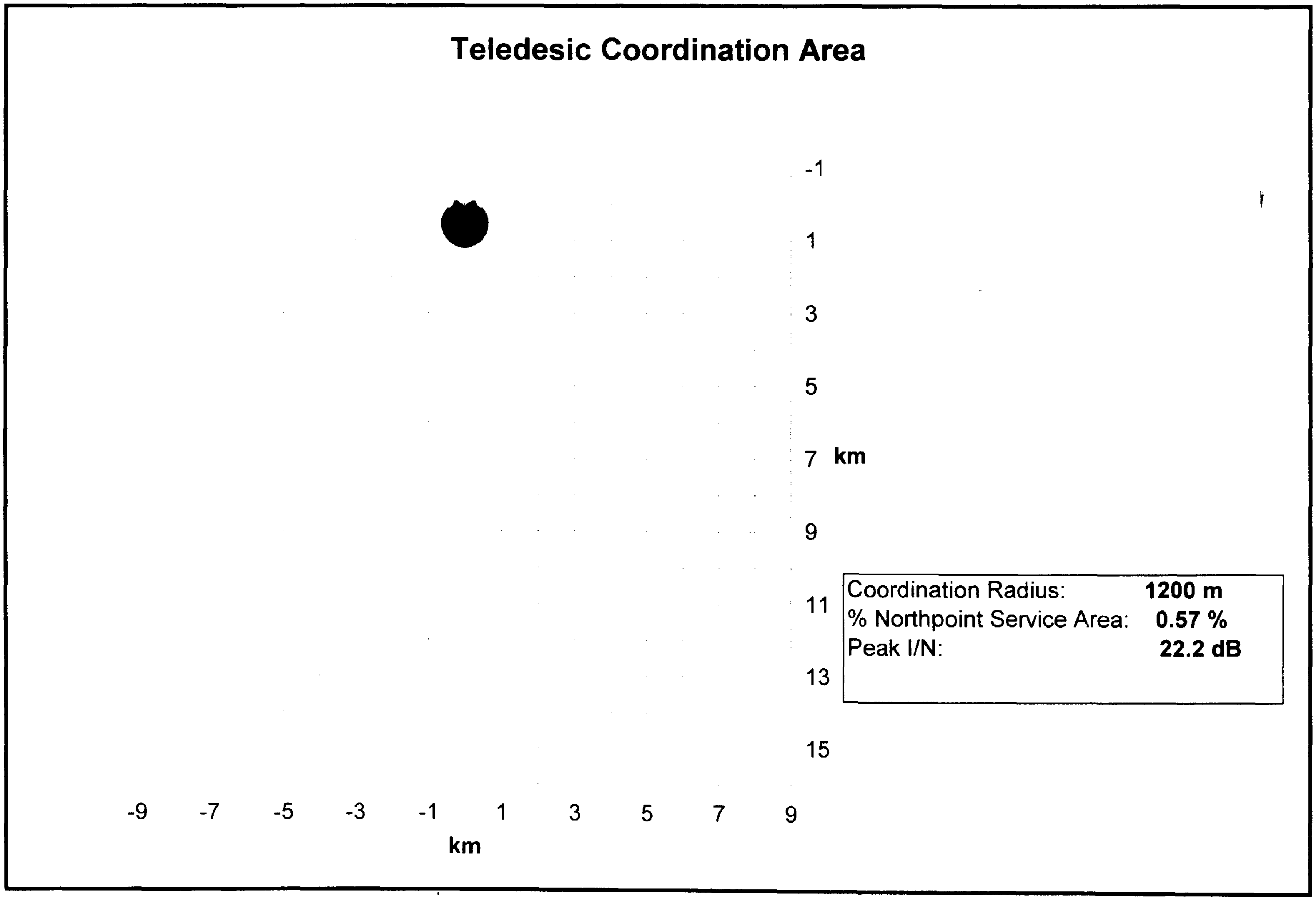
SkyBridge Coordination Area



Boeing BDS Coordination Area

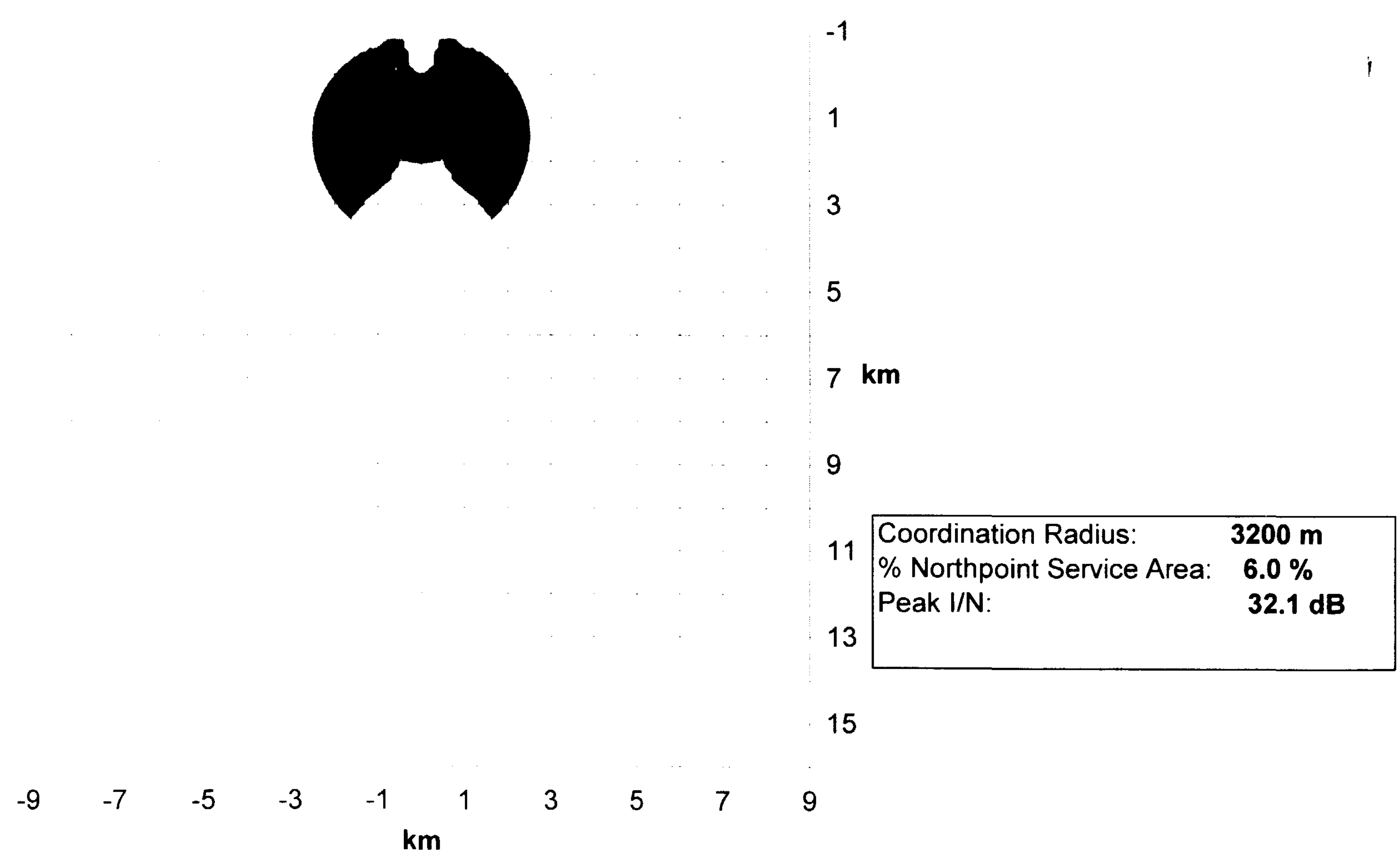



Boeing IDS Coordination Area
-1
1
3
5
7 km
9
11
13
15
-9 -7 -5 -3 -1 1 3 5 7 9
km
Coordination Radius: 200 m
% Northpoint Service Area: 0.06 %
Peak I/N: 18.9 dB

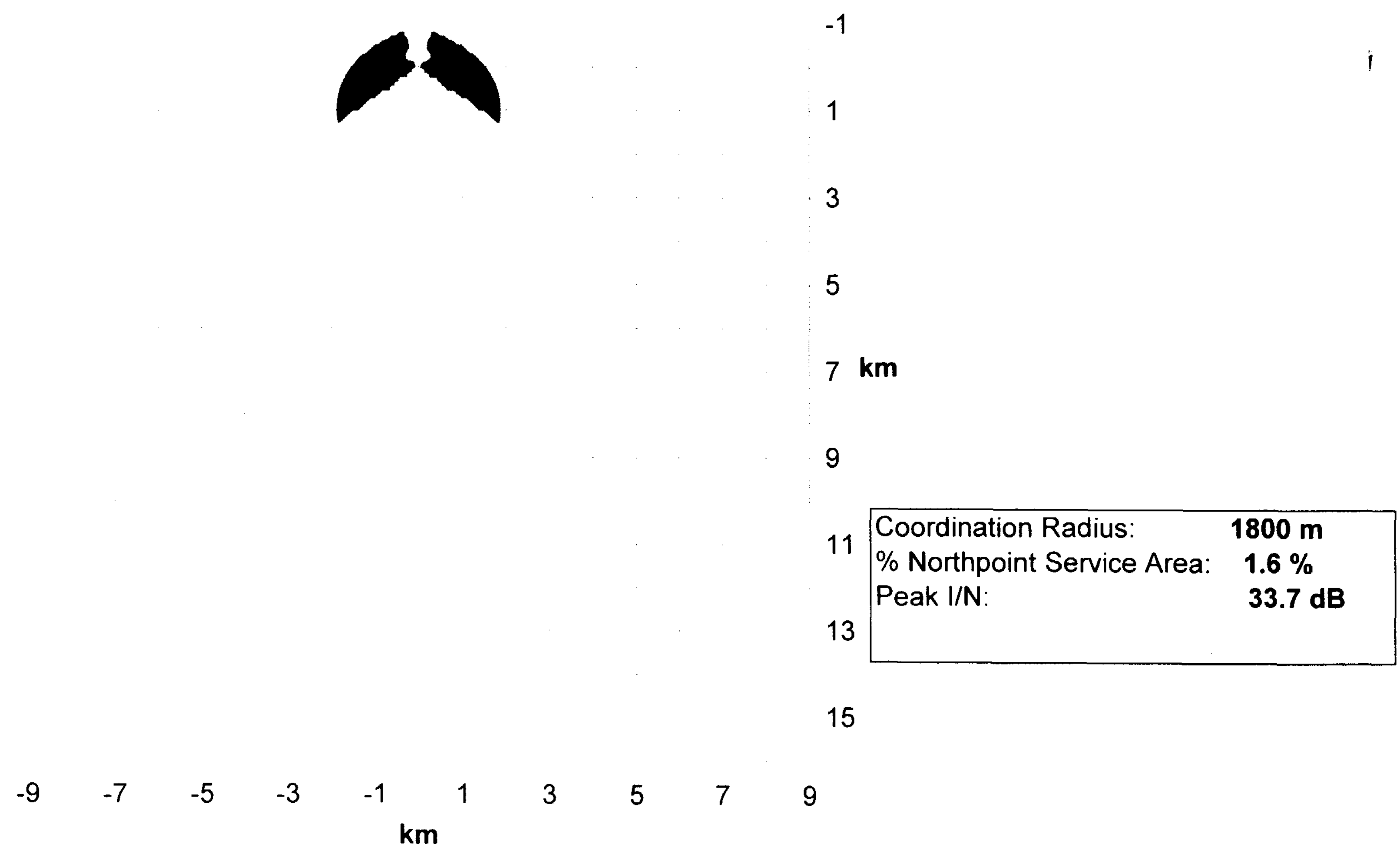


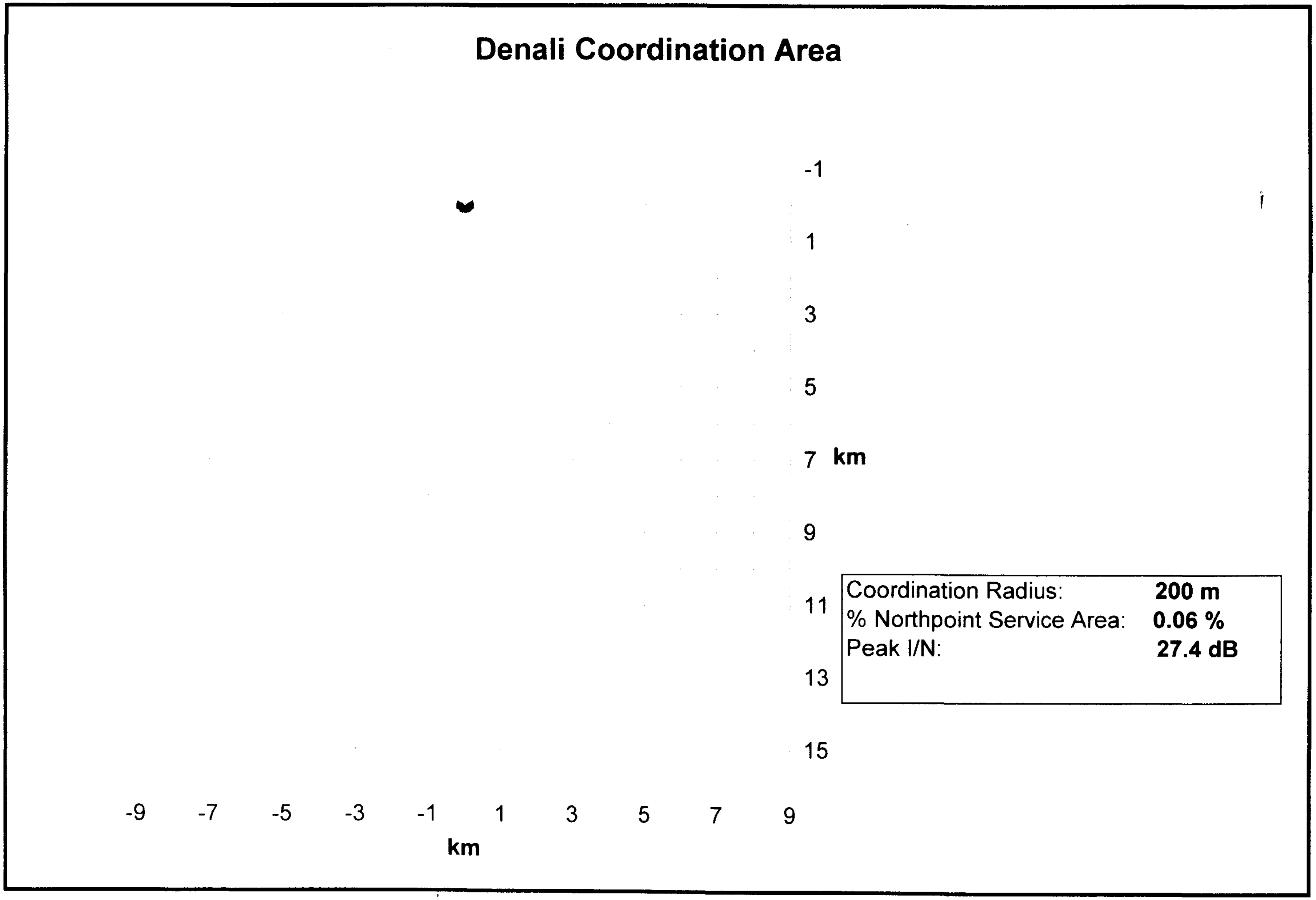
Teledesic Coordination Area
-1
1
3
5
7
9
11
13
15
km
-9
-7
-5
-3
-1
1
3
5
7
9
km
Coordination Radius: 1200 m
% Northpoint Service Area: 0.57 %
Peak I/N: 22.2 dB

Hughes Net Coordination Area

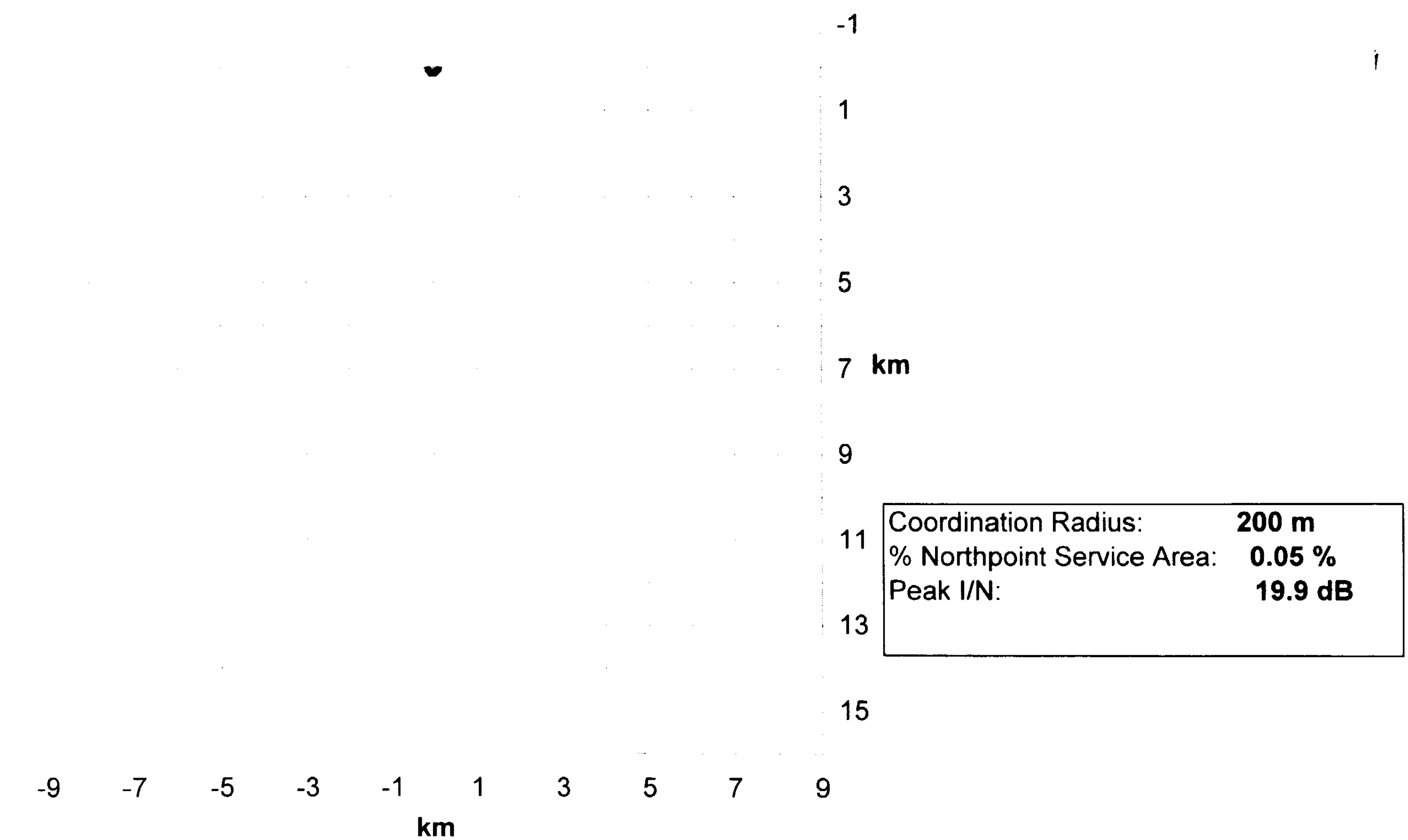


Hughes Link Coordination Area




Denali Coordination Area
-1
1
3
5
7 km
9
11
13
15
-9 -7 -5 -3 -1 1 3 5 7 9
km
Coordination Radius: 200 m
% Northpoint Service Area: 0.06 %
Peak I/N: 27.4 dB

Virgo Coordination Area



APPENDIX E— NGSO FSS SYSTEM CHARACTERISTICS

Table E-1. NGSO FSS Systems

System	Units	Boeing IDS	Boeing BDS	Teledesic	Hughes NET	Hughes LINK	SkyBridge	Denali Telecom	Virgo
Band Filed For	GHz	10.7-12.7	10.7-12.7	10.7-12.7	10.7-12.7	10.7-12.7	10.7-12.7	10.7-12.7	11.2 - 12.7
Amount of Frequency Sought	GHz	2 GHz	2 GHz	2 GHz	1 GHz	1 GHz	2 GHz	1 GHz	1.5 GHz
GSO Exclusion Zone		<15 deg of equator	<15 deg of equator	<18 deg of equator	< 10 deg of GSO		< 10 deg of GSO		<40 deg of equator
Minimum Service Elevation	deg	30	30	25	9	10	10	30 deg	42
Orbit Data		MEO	MEO	MEO	LEO	MEO	LEO	Quasi-Geo	Quasi-Geo
Num. Sats		20	20	30	70	22	80	15	15 (10 northern)
Num. planes		4	4	6	10	3 (1 equatorial)	20	9	3 (2 northern)
Sats/Plane		5	5	5	7	7/8	4	3/1/01	5
Altitude	km	13804	13804	3942	1490	15000	1469	varies	varies
Semi-Major Axis	km	20182	20182	10320	7868	21378	7847	30020/22890/26450	20281
Period	min	718.2	718.2			516	115.3	varies	478
Inclination	deg	57	57	70	54.5	45 and 0	53	63.4	63.435
Eccentricity		0	0	0	0	0	0	.59/.47/.71	0.66

Table E-2. NGSO FSS Satellite Transmitter RF Characteristics at 12.2 - 12.7 GHz

System	Units	Boeing IDS	Boeing BDS	Teledesic	Hughes NET	Hughes LINK	SkyBridge	Denali Telecom	Virgo
Gain	dBi	32.2	42	47.8	31.7	35.9	22.9	32.2	38
EIRP	dBW	45.4	43.3	54.8	34.1	46.9	29.3	51.2	50.3
Power	Watts	26.3(10.5)	1.7	5.0	1.7	25.1	4.4	79.4	17
Power	dBW	13.2	1.3	7	2.4	14	6.4	19	12.3
Tx Losses	dB	1	1	0	0.2	3	0	0	0
Ant. Pat		AP29	AP29	AP29	AP29	AP29	Note 1	AP29	AP29
Ant. Beamwidth	deg				4	2.5	5.2-18.2		
Ant. Diam	m				0.45	0.72	Note 2		
Transmit Bandwidth/Carrier	MHz	166.7	24	250	63	125	22.8	27	45
Constant PFD (isoflux)		no	no	no	yes	yes	yes	no	no
Beams per Satellite					210	50	24		

Note 1. Dynamically Varying
Note 2. Phased Array

Table E-3. NGSO FSS Receiver Characteristics at 12.2 - 12.7 GHz

System	Units	Boeing IDS	Boeing BDS	Teledesic	Hughes NET	Hughes LINK	SkyBridge	Denali Telecom	Virgo
RF Data									
Transmit Bandwidth/Carrier	MHz	166.7	24	250	63	125	22.8	27	45
constant PFD			no	no	yes	yes	yes	no	no
Beams per Satellite					210	50	24		
Ground Receiver									
Diam.	m				0.9	1.5			0.45
Gain	dBi	36.4	41.8	33.3	39.1	44.9	30.8/36	36.9	34(32.8)
G/T	dB	8.3	19.5	10.9		21.8	8.7/15.7		12.4
Noise Figure	dB					1.5			
Rx. Temp	dB-K	23.7	22.4	22.4	21.9	21.7	22.6	20.8	20.4
Rx. Temp	K	237.1	172.8	173.78	154.7	148.70	180/120	120	110
Noise Bandwidth	MHz								
Rx Beamwidth (Single Sided)	deg				0.92	1.2		2.5	1.85
Rx Ant. Pat		29-25*log					39-25 log		
Polarization									alternating
Eb/No Requirement	dB	3	5	2.5	5	5	3.5	12.5	4
System Margin	dB	1.1	0.6	3	1.7	2	0.1		0
Dynamic Atmospheric Margin	dB		6.5	5.3	4.2	2.8	Power Controlled		3.5
Modulation							CDMA		QPSK
Spot Size	km						350		
Ber		10e-10	10e-10	10e-10	10e-10				

Table 7. % Service Area with less than 20 dB Isolation

Satellite Longitude	148	119	101	85	61.5
Austin	0.07%	0.08%	0.00%	0.04%	0.10%
Bangor		0.18%	0.12%	0.08%	0.03%
Chicago		0.11%	0.04%	0.00%	0.09%
Los Angeles	0.17%	0.02%	0.12%	0.19%	
Miami		0.00%	0.00%	0.00%	0.00%
Seattle	0.14%	0.04%	0.14%	0.19%	

Table 8. % Service Area with less than 24 dB Isolation

Satellite Longitude	148	119	101	85	61.5
Austin	0.63%	0.53%	0.31%	0.40%	0.63%
Bangor		0.91%	0.72%	0.61%	0.52%
Chicago		0.69%	0.43%	0.36%	0.58%
Los Angeles	0.92%	0.56%	0.71%	0.92%	
Miami		0.18%	0.15%	0.03%	0.15%
Seattle	0.80%	0.60%	0.73%	0.98%	

Table 9. Minimum C/I isolation

Satellite Longitude	148	119	101	85	61.5
Austin	18.5	18.5	20.3	18.8	17.9
Bangor		17.4	17.4	17.8	19.0
Chicago		18.1	18.8	20.0	18.0
Los Angeles	17.3	19.5	17.4		18.8
Miami		21.2	20.8	22.7	21.4
Seattle	17.0	19.1	17.1	17.2	

2.5 Summary of sharing between Northpoint and DBS.

In this section, it was demonstrated that Northpoint Technology is fully compatible with DBS. Northpoint will never cause an outage to DBS in clear air, and Northpoint will not significantly degrade DBS signal reception. Indeed, Northpoint power levels are far below degradation levels, and therefore Northpoint will not cause harmful interference into DBS. DBS can tolerate a terrestrial interference C/I level of 8 dB, even in rain and for worst-case assumptions. Interference contours for the entire U.S. are presented in Annex 1. It is seen that Northpoint interference levels are maintained 17 dB below the DBS carrier in 100% of the service area, and 20 dB below carrier in 99.8% of the service area. Terrain blockage will further reduce interference levels. The maximum link degradation due to Northpoint in 99.5% of the service area will be less than 0.1 dB, and less than 0.3 dB in 100% of the service area. In the extremely rare case where 0.3 dB degradation causes interference (due to problems with customer equipment), the licensee can bear the burden of preventing interference to the few users affected.

CERTIFICATION

1. My name is Robert Combs and I am president of BCA International, a telecommunications consulting firm.

2. I have an ME in Systems Engineering from the University of Virginia, 1992; and a BS in Aerospace Engineering (Cum Laude) from the University of Texas (Austin), 1986.

3. I hereby certify that I am the technically qualified person responsible for the preparation of the Technical Annex to Reply Comments of Northpoint Technology.

4. The Annex, and the technical information in the Reply Comments, are complete and accurate to the best of my knowledge.

Dated: March 2, 1999

Robert Combs

Exhibit 2
DeLawder Communications, Inc.
Engineering Report

DELAWDER COMMUNICATIONS, INC.
5568 General Washington Drive, Suite A-218
Alexandria, Virginia 22312
(703) 658-5390

ENGINEERING REPORT

Northpoint Technology
Service Availability Statement

SERVICE AVAILABILITY

The point-to-multipoint fixed broadcast service which is being proposed by Northpoint Technology is predicted to provide to its customers a service availability of at least 99.7 percent within its service area; and this level of availability compares favorably with the existing DBS services[1]. As demonstrated below, this level of service availability also compares favorably with other video broadcast services, such as the VHF and UHF Television Service, and the Multipoint Distribution Service.

One can compare the above system availability to those of typical point-to-point microwave links, and conclude that the proposed service is unreliable. Such a comparison would clearly be inappropriate and wrong. Because of their very nature (which is quite different to the Northpoint Technology service, as shown below) point-to-point microwave links are typically designed to overcome high levels of atmospheric and multipath signal fading; and for this reason, such systems are associated with high link

[1] For example, DIRECTV™ submitted specifications of its system to the FCC on April 11, 1994 in a report entitled ***Terrestrial Interference in the DBS Downlink Band***. That report indicates that the DIRECTV™ design provides an availability in all areas of the U.S. better than 99.7 percent.

availability percentages. It is not uncommon to design such microwave links to have 30 to 40 dB fade margins, and corresponding link availability values of 99.9999 percent. The reason such a high link availability is necessary for a point-to-point microwave link is due to its nature as a non-broadcast, intermediate-stage wireless communications link. As such, it represents a single wireless link between one or more senders, and many, many receivers of the information being sent along that link. Any outage to one intermediate-stage microwave link would result in outages (or non-service) to perhaps thousands of customers. (A typical studio-to-transmitter link of a VHF or UHF television station would be an example of an intermediate-stage microwave link.) Under such circumstances, the high service availability of any intermediate-stage point-to-point microwave link is required to prevent "wide-area" outages to a communications system from occurring for more than a few minutes per year.

More typical of a commercial broadcast service (which it is), the proposed terrestrial microwave system of Northpoint Technology represents the "last-stage" wireless transmission link between the service provider and the customer. As a broadcast service, the proposed system's service availability need only achieve a level which is equivalent to other broadcast services in order to compete sucessfully for market share; and it need not achieve the higher levels associated with point-to-point microwave links. After all, should the link to any one receive location (customer premise) prove to be unreliable, that single link causes unavailability of service to only that one customer premise, or household. (For multiple dwelling units {MDUs}, more than one "household" may be effected; but even those within a given MDU, relatively-speaking, can be considered small in number.)

The service availability requirements of this proposed point-to-multipoint broadcast service is similar to other "last-stage" broadcast services - such as VHF and UHF Television, and Multipoint Distribution Service - and its service availability should be compared with these services. Such a comparison is provided, below.

Northpoint Technology
Service Availability Statement

A. A Comparison to VHF and UHF Television Service Availability

In 1959, the Television Allocations Study Organization (TASO) investigated viewer perception of television picture quality. As a result, six levels of picture quality were defined as (1) excellent, (2) fine, (3) passable (or acceptable), (4) marginal, (5) inferior and (6) unusable. Using the TASO results, the FCC then defined the Grade A and Grade B television signal contours which are meant to represent the two levels of service used to defined coverage and protection requirements for the standard television service. In particular, the Grade B contour (which is used to represent the extent of a VHF or UHF station's service area) is a specified field strength that is predicted statistically to occur at the best 50 percent of the receiving locations for 50 percent of the time. In addition, at this specified field strength, one could expect to receive a picture of "acceptable quality" (TASO level 3 or better) at 50 percent of the locations for 90 percent of the time. Therefore, the availability of "acceptable quality" service or better at the Grade B contour of a VHF or UHF station is predicted to be no greater than 90 percent. It is this level of availability that predicted service and protection levels for standard broadcast television (and latter low-power TV) are based.

Digital TV (DTV)

In the FCC's *Advanced Television Systems and Their Impact upon the Existing Television Broadcast Service - Sixth Report and Order (MM Docket No. 87-268, released April 21, 1997)* (hereafter "Sixth R&O"), the Commission instituted policies and rules to add digital television (DTV) service to the VHF and UHF broadcast television service. Paragraph 29 of the Sixth R&O reads, in part, as follows:

> We continue to believe that our service replication proposal, with some modifications, is the appropriate approach for implementation of DTV. **We believe that providing DTV allotments that replicate the service areas of existing stations offers important benefits for both viewers and broadcasters.** {Emphasis added}

As further demonstrated in Paragraph 199 of this Report and Order, replication of the NTSC service area was used in the determination of DTV facilities:

Northpoint Technology
Service Availability Statement

The computer model permits the rapid computation and analysis of service area coverage provided by the NTSC and DTV systems, both on an overall cumulative basis and for individual stations. The service area of an individual NTSC station is defined as the area within the station's Grade B service contour, reduced by interference; and is computed based upon the actual transmitter location, power, and antenna height. The service area of a DTV station is defined as the area contained within the station's noise-limited service contour, reduced by the interference within that contour. **DTV coverage calculations assume locations and antenna heights identical to those of the replicated companion NTSC station and power generally sufficient to achieve noise-limited coverage equal to the companion station's Grade B coverage.** {Emphasis added}

The noise-limited contour of a DTV station is represented as an acceptable picture received for 50 percent of the locations and 90 percent of the time. This level of service availability is less than the availability proposed by Northpoint Technology.

B. A Comparison to Multipoint Distribution Service (MDS) Availability

MDS is sometimes referred to as "wireless cable"; and this service is also used to provide a point-to-multipoint terrestrial broadcast microwave signal to customer premises in a licensed market. MDS operates in the 2.1 GHz and 2.5 to 2.7 GHz frequency bands.

Most of the criteria used to develop a service area for MDS is effectively discussed by the FCC in *Amendment of Parts 21, 74 and 94 of the Commission Rules and Regulations with regard to the technical requirements applicable to the Multipoint Distribution Service, the Instructional Television Fixed Service and the Private Operational-Fixed Microwave Service (OFS) - First Report and Order (General Docket No. 80-113, released June 14, 1984)* (hereafter "First R&O"). Paragraph 66 (under the subheading "The Protected Service Area Boundary"), reads, in part, as follows:

> In the *Notice*, we determined the boundary of the proposed protected service area by first defining what constitutes a minimally acceptable picture and then calculating the signal level needed at the receiver to produce such a picture. In particular, we calculated the power flux density required to produce a minimally acceptable television picture 99.9 percent of the time. In making this calculation, we assumed the use of reasonable reception equipment and worst case propagation conditions. The protected service area boundary was defined to be equivalent to the calculated power flux density contour. **The policy underlying our proposal was that the protected service area should be the area in which service would <u>generally</u> be available.** {Emphasis added}

Northpoint Technology
Service Availability Statement

While 99.9 percent appears to be a higher availability standard than proposed by this service, further examination of the MDS report establishes that it is not. Under the subheading "The Minimally Acceptable Picture" (Para. 68), the FCC accepts a minimally acceptable picture to be the equivalent to a TASO Grade (or Level) 4 picture "as judged by 50 percent of those viewing the picture." This picture is referred to as "marginal" and is described as being "poor in quality causing the viewer to wish it could be improved". Furthermore, in responding to those whom raised objections to the use of a TASO Grade 4 picture, in Paragraph 72 the FCC states the following:

> Further, the effect of raising the {TASO Grade} standard for what constitutes a minimally acceptable picture is to reduce the size of the protected service area if all other factors remain the same. For instance, if we were to raise the standard to a TASO Grade 3 as perceived by at least 90 percent of those viewing the picture, the required signal-to-noise ratio would be approximately 10 dB higher or 33 dB. Using the equations derived in Appendix 2 of the *Notice*, it can be shown that this signal-to-noise ratio would be available under worst case propagation conditions at a distance of 9.5 miles from the transmitter. We do not believe that a **decrease in the size of the service area** of this degree is justified by the benefits that would be derived from adopting a higher standard for the minimally acceptable picture. {Emphasis added}

Northpoint Technology
Service Availability Statement

What is obvious is that had the FCC used a similar standard for MDS as it did for VHF/UHF TV in the determination of a service area, the area they ultimately decided to protect for MDS would have been reduced by approximately 5.5 miles[2]. The reliability for MDS is, therefore, considered to to below that of VHF and UHF Television.

[2] The protected service area defined for an onmidirectional MDS station was 15 miles.

DELAWDER COMMUNICATIONS, INC.
5568 General Washington Drive, Suite A-218
Alexandria, Virginia 22312
(703) 658-5390

ENGINEERING REPORT

Northpoint Technology
Service Availability Statement

I, Darryl K. DeLawder, declare and state as follows:

That I have received a Bachelor of Science degree in electrical engineering from Villanova University;

That I have either prepared or directly supervised the preparation of all technical information contained in this Engineering Exhibit;

That the facts stated in this Engineering Report are true of my own knowledge, except as to such statements as are herein stated to be on information and belief, and as to such statements I believe them to be true.

03-01-99

Date

Darryl K. DeLawder

Exhibit 3
Testimony of Charles W. Ergen

TESTIMONY OF CHARLES W. ERGEN, CEO,
ECHOSTAR COMMUNICATIONS CORPORATION
BEFORE THE ANTITRUST AND BUSINESS RIGHTS
SUBCOMMITTEE OF THE SENATE COMMERCE
ON THE JUDICIARY
JANUARY 27, 1999